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IRA REMSEN AND AMERICAN CHEMICAL RESEARCH LITERATURE[1]

By Dr. FREDERICK H. GETMAN

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WITH the return of peaceful conditions following America's wars with England, the energies of the people were soon directed intensively toward the development of the natural resources of the country and to the extension of its western frontier. An awakened sense of nationality and destiny, as well as a sense of the immensity of the task of material exploitation, had begun to influence all classes.

As a recent historian has pointed out:

> Over the mountains the great valley two thousand miles wide, with its unified river systems four thousand miles long, opened an empire such as man had never seen.

This intensive concentration of the nation's efforts toward the discovery of our natural resources and to the development of economic methods for their utilization in the arts naturally led to the creation of an urgent demand for trustworthy sources of information concerning the latest discoveries in both pure and applied science.

It was to meet this growing need that Benjamin Silliman, professor of chemistry and natural history at Yale College, founded the *American Journal of Science and Arts* in 1819.

This journal may justly be regarded as the forerunner of all American scientific periodicals. In the first number of the journal, Silliman outlined the scope of his projected periodical in these historically significant words:

[1] Read at the luncheon of the alumni of the Johns Hopkins University in attendance at the meeting of the American Chemical Society in Cincinnati, Ohio, April 8–13, 1940.

This journal is intended to embrace the circle of the Physical Sciences, with their application to the Arts, and to every useful purpose. It is designed as a deposit for *original American Communications;* it will contain also occasional selections from Foreign Journals, and notices of the progress of Science in other countries. Within its plan are embraced *Natural History,* in its three great departments of *Mineralogy, Botany* and *Zoology*—as well as *Chemistry* and *Natural Philosophy* and their various branches along with *Mathematics,* pure and mixed. It will be a leading object to illustrate *American Natural History,* and especially our *Mineralogy* and *Geology. The Applications* of these sciences are obviously as numerous as *physical arts,* and *physical wants;* for no one of these arts or wants can be named which is not connected with them. While science will be cherished *for its own sake* and with due respect for its own *inherent dignity,* it will be employed as the *handmaid to the arts.* Its numerous applications to *Agriculture,* the earliest and most important of them; to *Manufactures,* both mechanical and chemical; and to *Domestic Economy,* will be carefully sought out and faithfully made.

With this ambitious program, Silliman's journal made its appearance as America's first scientific periodical and, for one hundred and twenty years, it has continued to maintain its position as the dean of America's scientific journals. The pages of the early numbers of this journal afford a bird's-eye view of the state of scientific learning in the United States during its formative period, while the names of many of its scientific pioneers, along with an account of their experiments, furnish a wealth of interesting reading for the scientific historian.

Upon the death of Benjamin Silliman in 1853, his journal was carried on under the editorial supervision of his son, Benjamin Silliman, Jr., with the cooperation of James and Samuel Dana as co-editors.

The rapid growth of the country, together with the corresponding development of science, both pure and applied, ultimately compelled the editors to confine the scope of Silliman's journal to articles dealing solely with pure science. With this restriction of scope, the title of the publication was changed to the *American Journal of Science.* This change of policy may be regarded as marking the beginning of the process of journalistic segregation which has since that time proceeded at an ever accelerating pace.

Prior to 1879, several sporadic attempts had been made to establish a journal devoted exclusively to chemistry. Thus, in 1813, a single volume of scientific memoirs was issued by the Columbian Chemical Society, while from 1870–1877, a periodical known as the *American Chemist* was edited by Charles F. and William H. Chandler. This may properly be regarded as the first chemical periodical in America.

Although the American Chemical Society had already been organized in 1876, the first number of its journal did not appear until three years later, while it was not until 1893 that regular monthly numbers were issued.

Edward Hart had, in 1887, established the *Journal of Analytical Chemistry;* the title of this periodical was changed four years later to the *Journal of Analytical and Applied Chemistry.* This journal was subsequently merged with the *Journal of the American Chemical Society* in 1893, at which time its editorial supervision was entrusted to Dr. Hart.

Shortly after delimiting the scope of the *American Journal of Science,* its editorial staff took a further step which was destined to mark the beginning of a new era in American chemical publication.

The Johns Hopkins University had only recently opened its doors, and its chemistry department, under the direction of Ira Remsen, soon became a veritable Mecca for graduate students of chemical science. Shortly after assuming the chair of chemistry at Williams College, prior to coming to Baltimore, Remsen had begun to send papers embodying the results of his experimental researches to the *American Journal of Science.* After coming to Baltimore his chemical contributions to this journal steadily increased until, in 1879, the editor, James D. Dana, becoming alarmed at their number, was obliged to decline any further material from the Johns Hopkins laboratory. Referring to this incident in later years Remsen wrote:

> In a short time my manuscript was returned with the statement that it would be necessary to find some other place to publish my articles, as they seemed too highly specialized for a journal of general science. Professor Dana very kindly suggested that I start a journal myself. After corresponding with the leading workers in chemistry with discouraging as well as encouraging results, I decided to act upon the suggestion, and early in 1879 the first number of the *American Chemical Journal* was issued.

Thus, it came about that after sixty years as America's leading scientific periodical, the *American Journal of Science* found it impossible any longer to afford unrestricted space for the constantly increasing number of chemical papers submitted for publication. History was again repeating itself; for just as in 1819, following the country's struggle for independence, the *American Journal of Science* had come into existence to meet the need for a source of information in the field of general science, so in 1879, following the dark days of civil conflict, Remsen established the *American Chemical Journal* as a medium of publication for the rapidly multiplying papers resulting from the awakening of American institutions of learning to the importance of chemical research.

The task of launching a journal of this nature was an undertaking calling for both courage and wisdom. In assuming this task Remsen was undoubtedly in-

spired by the memories of his idol and one-time teacher, Liebig, of whom he later wrote:

> It was my good fortune to come under the influence of Liebig in my early years as a student of chemistry. For a full academic year I had the privilege of sitting at his feet and hearing him expound the elements of chemistry. I also came to know him, as a youth may know a master, and this association has been the chief inspiration of my life. Liebig impressed me so strongly that I have been led to study his life more carefully than I have ever studied any other life. And the more I have studied it the more strongly I have been impressed.

During his student days in Germany, Remsen had read through the entire *Annalen der Chemie* and thus quite unconsciously there had been imprinted on his mind a pattern of scientific journalism worthy of subsequent emulation. In fact, in the establishment of the *American Chemical Journal* we may well believe that Remsen treasured the secret hope that his journal might ultimately become the *American Annalen*.

Inspired by such an ambition and qualified by experience, both in teaching and research, Remsen's success as an editor was practically assured. Any doubts which he may have felt in this new undertaking were soon dispelled by the enthusiastic reception the journal received from members of the chemical profession both at home and abroad. In referring to the early days of the journal, Remsen wrote:

> The editor of the new journal was entirely inexperienced in the work that devolved upon him, and he owes much to the wise counsel and friendly co-operation of Professor Dana. At first, six numbers a year were published and there were many times when there was difficulty in filling these. By 1889 the supply of material had increased to such an extent as to lead to an enlargement. After this for seven years, eight numbers a year were issued. Beginning in 1896, ten numbers a year were issued; and, finally, in 1899, the Journal became a monthly publication, and even then it was found difficult at times to take care of all the material that was sent in.

That he was gratified by the success of his journalistic venture is reflected in a letter sent to his wife soon after the appearance of the first number of the periodical. He wrote:

> Yesterday I worked all day on matters connected with the Journal. I enjoy the work as proof is coming in every day, and it is really delightful to see the thing growing from day to day. I take a genuine pride in it.

Professor Remsen never relinquished the editorial supervision of his journal, despite ever-increasing official duties. Even when, as president of the Johns Hopkins University, the employment of an assistant-editor became necessary, he never wholly delegated his editorial duties to other hands. The meticulous attention given by him to his editorial duties have been entertainingly recalled by one of the assistant editors during this period. From these recollections we are privileged to catch a glimpse of that fabled retreat, "the editorial sanctum," of which the poet has written:

> Who would not be an editor.—To write
> The magic 'we' of such enormous might;
> To be so great beyond the common span
> It takes the plural to express the man;

While from these recollections we learn that the force of the editorial "we" was frequently invoked, at the same time we find that throughout the administration of his office as editor he was never unreasonable or dictatorial. He was insistent upon extreme care and promptness in correcting proof and was wont to become quite impatient with authors who would not promptly read and return their galley proofs. He often said that one great trouble with young chemists with their first papers in type was that they wanted to show the proof to all their friends without regard to the necessity of returning it to the editor without delay. Before being sent to the printer all copy was reread and carefully corrected, while particular attention was given to the observance of certain editorial conventions such as the proper use of the suffixes "in" and "ine." Instinctively an adept in the use of unambiguous, incisive English, Remsen's natural ability as a writer had been so whetted by experience as an author and lecturer that, when he assumed the role of editor, he had become a veritable master in the use of his native tongue.

It is not surprising, therefore, to find him debating with one of the professors in the department of English at Johns Hopkins as to whether one should write "20 grams *was*," or "20 grams *were* taken." He was also very particular as to correct orthography and on one occasion remarked: "A man is not a chemist until he learns how to spell guaiacol!"

It should be pointed out that he by no means accepted everything that was submitted to him for publication. Even at the risk of incurring the resentment of some of his would-be contributors, he consistently refused material which might tend to lower the high standard he had established for his journal. It should be repeated, however, that notwithstanding Remsen's insistence that authors must strictly conform to certain fundamental editorial rules and conventions which he had established, he was never unreasonable or inconsiderate in his editorial requirements. In fact, one who assisted him in his editorial labors has said of him, "Dr. Remsen, if anything, leaned backward in his efforts to be fair and absolutely impartial."

Thus it came about that the *American Chemical Journal* was soon regarded, both in this country and abroad, as one of the important chemical publications of its time. It has been justly appraised by Professor W. A. Noyes as "The first really scientific journal of research chemistry in America."

One needs only to scan its pages to find among its contributors those whose names constitute the honor-roll of American chemistry during the last quarter of the nineteenth century.

In 1915, upon the completion of the fiftieth volume, the *American Chemical Journal* was merged with the *Journal of the American Chemical Society*. This action was taken with Remsen's unqualified approval.

In referring to this eventful step, the retiring editor said:

> For a number of years the *American Chemical Journal* contained the principal original contributions that came from this country. It flourished beyond my expectations, but within the last few years it became evident to me that the journal of our society was coming more and more to be looked upon by American chemists as the best medium of publication of their contributions and, somewhat reluctantly and with a sacrifice of sentiment, I transferred my Journal to the tender mercies of the Society in full confidence that the interests of American chemists would, on the whole, be better served by consolidation than by separate existences.

And then he added with characteristic modesty:

> I think it probable that the *American Chemical Journal*, especially during the early years of its existence, exerted a stimulating influence upon chemical research in America, but no one can measure the influence, and it is perhaps idle to refer to it as a possible factor.

After having served for nearly a decade as editor of the *Journal of the American Chemical Society*, Dr. Hart was succeeded by Dr. William A. Noyes. It should be noted that both of these men had pursued graduate work at the Johns Hopkins University under Remsen. The former, who enjoyed the distinction of having been one of the first to receive one of the coveted graduate fellowships in chemistry at Baltimore, received his degree in 1879, while Dr. Noyes earned his doctorate three years later.

When the *American Chemical Journal* was incorporated with the *Journal of the American Chemical Society* we may well believe that Remsen felt no uncertainties as to the future welfare of his child on surrendering its editorial management to his former pupil, Dr. William A. Noyes.

In 1917, after fifteen years of distinguished service as editor of the journal of the society Dr. Noyes was succeeded by Dr. A. B. Lamb, the present editor. By this act the editorial mantle of Remsen and two of his pupils, Hart and Noyes, was transferred to the shoulders of a son of Harvard. It is scarcely necessary to point out that the traditions of former years are being cherished as a worthy heritage and despite the fact that "New conditions teach new duties," and although "Time makes ancient good uncouth," even so our journal continues to reflect the lofty aims of its founders.

With the dawn of the twentieth century the need for an American *Centralblat* had become apparent and, ultimately, in response to the desire of many of its members, the society inaugurated in 1907 the publication of *Chemical Abstracts*. Here again the editorial supervision of this new periodical was entrusted to two "Hopkins" chemists; initially to Dr. Noyes and subsequently to Dr. A. M. Patterson.

The day in American history was fast passing when a chemist could enjoy the distinction of knowing something about everything in his science and in place of this more or less unwarranted reputation came the urgent demand for a man knowing everything about some one thing in chemistry. Quite relentlessly the era of intensive specialization superseded that exceedingly comfortable period when a first-class chemist's knowledge of his subject was limited by practically no horizons. Journals devoted to highly specialized domains sprang into existence with bewildering rapidity until to-day no less than forty strictly scientific journals are to be found in our current American chemical literature. Among these the *Journal of Chemical Education* and the *Journal of Rheology* claim our attention because of the association of the names of two other "Hopkins" chemists with their editorial management. The first editor of the former was Dr. Niels Gordon, while the editor of the latter, since its inception, has been Dr. Eugene C. Bingham. Both of these gentlemen, it should be noted, trace their chemical ancestry back to Ira Remsen.

In addition to this imposing list of journals we must not omit to mention the valuable scientific and technological monographs sponsored by our society which have been appearing at frequent intervals since 1920 under the editorship of W. A. Noyes, John Johnston and Harrison E. Howe.

And to-day, when many a chemist is finding it well-nigh impossible "to keep abreast of (chemical) truth" and when, moreover, a slender income precludes the possibility of extensive subscription to chemical journals, another Remsen disciple, Dr. Atherton Seidell, brings forward the bibliofilm as a means of solving the difficulty. The future of this *multum in parvo* library can scarcely be foreseen, but it has already proven to be of inestimable value to research chemists residing in isolated sections of the country.

In this brief review of the history of chemical journalism in America one fact of especial interest to all Hopkins chemists stands out and that is that the imposing array of our chemical periodicals, and especially those sponsored by the American Chemical Society, may quite justly be regarded as "the lengthened shadow of one man"—Ira Remsen.

THE PUBLICATION OF SCIENTIFIC RESEARCH

By Dr. ATHERTON SEIDELL
U. S. PUBLIC HEALTH SERVICE

THE periodicals devoted to the publication of scientific research are of the most varied character. They may contain relatively few original papers or be devoted exclusively to such reports. They may appear at very irregular intervals or sufficiently frequently to make several volumes per year. They are published in many countries and under widely varying conditions.

The majority are issued at the expense of academies, governmental agencies, scientific societies or other organizations having for their object the promotion of one or several branches of science. Some are house organs of industrial establishments. A certain number are published by private initiative on a more or less self-supporting basis. In general, however, purely scientific periodicals require some form of subvention. Those sponsored by scientific societies are usually supported by dues received from members.

They are in all cases collections of reports upon many different problems in one or several fields of science. For this reason any one journal contains papers upon a far greater variety of subjects than are of direct interest to an individual or small group of research workers. To obtain the papers concerned with a given problem, a far larger number of reports of no immediate application to that problem will be simultaneously received. These increase the cost of those desired both for their acquisition and subsequent conservation.

Due to the varied character of scientific periodicals the published reports upon given problems are scattered in a larger number of journals than can usually be afforded by individual workers. Such persons must therefore depend upon the collections of the larger institutions for their literature requirements. For this reason scientific research can usually be advantageously pursued only in proximity to adequate library collections.

The present system of publishing original scientific research thus restricts its acquisition to the community of workers. This is in striking contrast to that other important class of scientific literature composed of digests, treatises, reviews, text-books, etc., which is largely distributed to individual students and specialists. The market for the one is accordingly restricted and that for the other of far greater diversity.

In addition to this difference in market there is also a difference in the literary character of the two classes of publication. The one consists almost exclusively of concise and very accurate descriptions of natural phenomena or of experimental investigations, contributed by numerous individuals. The other, represented by monographs, compendia, text-books, etc., consists of the orderly presentation and critical discussion of the facts disclosed in the original communications published in the journals. They are usually written by one or a small group of authors and depend for their success upon the manner of treatment of the subject and the clarity and excellence of the presentation. They are essentially the type of literary production for which the author is entitled to the protection afforded by copyright. This can not be claimed with equal justice for the original communications published in the scientific periodicals. These are essentially contributions to the advancement of science, offered in return for reciprocal benefits derived from the similar contributions of others. Any restriction upon their most widespread use, which might be imposed by copyright, is not only contrary to the wishes and best interests of research workers but also indirectly to the public welfare.

There is furthermore an essential difference in the risk involved in the publication of these two classes of scientific literature. In the case of periodicals their sale is largely provided for in advance by subscriptions and, after each issue is distributed, very little if any further returns can be realized from reserve stocks. Copyright protection is accordingly of negligible value. In the case of compilations, treatises, text-books, etc., the risk must be wholly assumed in advance by the author and publisher. The entire profits are derived from the sale after publication, hence copyright protection is indispensable to assuring a just reward of the efforts which the undertaking has involved.

In recent years a procedure for the greater diffusion of reports of original scientific investigation than can be secured by journal publication alone, has been developed. This consists in the photographic reproduction upon microfilm of the separate articles in the periodicals and the distribution of these to workers who do not have access to the journals in which the reports are published.

The process is the most economical so far devised for making a single copy of a given text. By means of it the scattered articles upon a given research problem can be segregated from the numerous others with which they are published in journals. The research worker is enabled at small cost and without effort to collect the papers pertaining to the problem

upon which he is engaged. It has rendered proximity to adequate literature collections no longer an indispensable requisite to the prosecution of experimental research.

Microfilm copies offer a number of advantages over the printed texts as contained in the bound journals. Among these is their insignificant bulk, which permits the assembling of a far larger number of papers at one time than can be brought together in the bound volumes of journals each containing only one or a very few papers on a given subject.

Furthermore, the collected microfilm copies of papers can be kept and need not be returned promptly to the library for the use of others, as is the case with the bound periodicals. The microfilm copies when attached to cards or sheets of papers lend themselves to filing for future reference exactly as manually prepared notes, reprints or any other collected material upon a given subject. They are especially adapted to the assembling in the most convenient form of the large numbers of scattered publications required by authors of compendia, treatises, textbooks and all other digests of scientific literature.

Microfilms, however, have the disadvanatge that they differ in form from the ordinary printed page with which from long habit one has become accustomed, and in addition require special means for reading them. The devices which are available for this are monocular magnifiers and projection apparatus. The former, although quite inexpensive, require a certain effort for use, and the latter have not yet been produced at a price within the means of most individuals. Since, however, microfilm copies usually represent only a small fraction of the literature collections made by individuals, the effort to read them will not be a serious task, and will be very largely repaid by the advantage of having at hand the photographic copy of the original publication.

In connection with microfilm copying from scientific periodicals, only one criticism has so far been advanced. This is in reference to the possible effect the increasing use of microfilms may have upon subscriptions to journals. It is apparent, however, that such an apprehension is ill-founded when the total amount of published original research is considered in relation to the inconsiderable fraction of it that may be desired and can be copied in the form of microfilms. If, for example, the field of medical research is considered, the total number of titles of books and journal articles listed during the last 60 years by the Index Catalogue of the Army Medical Library is about 2,500,000. If it is assumed that one half of these have become obsolete, a request for a single copy of each of the remaining 1,250,000 would require more than 100 times the microfilming equipment and number of persons employed in the several services now operating. Even if microfilm services should attain 100 times their present capacity only a single complete copy of any one journal would, on the average, be distributed as microfilms in one year. This corresponds to fewer copies than are given away by authors in the form of reprints supplied by the publishers. It is evident, therefore, that microfilm copying can not justly be charged with adversely influencing subscriptions to scientific journals.

The real cause of the failure of certain scientific periodicals to attract and retain a sufficient number of subscribers to pay the cost of their publication is the diversity of their contents. There is probably a close relationship between the financial stability of a journal and its degree of specialization. Those journals serving a particular field of research become indispensable to the workers in that field and will be supported by individuals, whereas those containing papers upon many branches of science can be afforded only by large institutions in which research in many fields is being pursued.

Periodicals of this latter type have in many cases been founded without due regard to the purposes to be served. They sometimes simply satisfy the aspirations of those responsible for their existence or may be used largely as exchanges for securing other periodicals. They frequently become the cemeteries in which useful descriptions of original research are buried. They greatly increase the difficulties of bibliographic searches and contribute to the chaos in publication which now prevails. It is evident that a complete reorganization of the present system of publishing the results of scientific investigation is needed.

Toward this end an advisory council on publication should be organized in each country for the purpose of studying the existing periodicals and defining more precisely the character of the contributions to be published in each. A system of routing the original communications in accordance with the field covered by each journal should also be established. The more highly specialized periodicals produced in this manner would enable the subscribers to receive more papers in which they are interested and fewer on subjcts with which they are not concerned. The individual research worker would find it to his advantage to subscribe to them, and the cost of their publication would thus be distributed to an increasing extent among those for whose special benefit they are produced.

The supervision of publication by a central agency in each country would probably result in the elimination of some journals and avoidance of the many changes in character, policy, title, size, price, etc., in others which now so greatly complicates the collection and maintenance of complete sets of periodicals

by libraries and the task of making bibliographic searches in them.

Although abstract journals aid in reducing the disadvantages of the haphazard publication of scientific research by classifying and indexing the papers contained in the journals, they constitute a partial republication of the original contributions and to this extent are uneconomical. A part of the cost of publishing abstracts could probably be saved if the contents of the journals themselves were sufficiently uniform to permit workers to obtain directly a larger proportion of the original papers in which they are interested.

It is also probable that if abstract journals themselves were restricted to narrower fields, those using them would be better served at a lower cost. If, for example, *Chemical Abstracts,* which now attempts to cover the entire field of chemistry, were issued in several parts, chemists would be relieved of the obligation of purchasing and conserving the abstract literature of those branches of chemistry in which they are not directly engaged. It is apparent that the urgent need in the publication of scientific research is a greater degree of specialization in both the periodicals and the abstract journals.

In addition to the problem of better organization of scientific publication there is also the question of securing the funds for printing the rapidly increasing number of papers which are being written. Practically all journals are forced to either refuse many papers or publish them in such condensed form that their usefulness is greatly impaired. A plan for relieving this situation, based upon the use of microfilms, has recently been proposed by Watson Davis, director of Science Service. This plan has been designated "Auxiliary Publication" and provides that papers which editors are unable to accept in their complete form be condensed for printed publication and, in connection with such résumés, notice given that the complete paper with all the charts, tables and explanatory details has been deposited with a central agency which distributes microfilm copies of it at a modest stated price. Thus for purposes of bibliographic classification the paper is widely circulated in curtailed printed form and for the benefit of those directly interested in the details of the work it is distributed as photographic microfilm copies. The organization of Auxiliary Publication is a task which advisory councils on scientific publication in each country should undertake in connection with the supervision of publication in general.

A common reproach to scientific investigation is that adequate use is not made of so much of it that is published. The cause of this is simply the inaccessibility of such a large proportion of it to those capable of using it to advance science. Aside from the introduction of microfilm copying no improvement in the means of distribution of original description of scientific research has been made in recent years. The perfection and extension of microfilm copying as well as the reorganization of the printed publication of scientific research is deserving of the earnest support of all who are interested in the advancement of science and the public welfare.

SCIENTIFIC EVENTS

RESERVATION BY THE U. S. FOREST SERVICE OF A VIRGIN HEMLOCK-BEECH FOREST

THE U. S. Forest Service has announced the formal setting aside of 4,131 acres of essentially virgin hemlock-beech forest, on the Allegheny National Forest in northwestern Pennsylvania, to be devoted permanently to scientific use and for the education and enjoyment of the public. This area is seven miles south of Ludlow, and is unique in that it contains the largest acreage of original forest of its type in the east. It is also the largest single remaining body of virgin timber between the Adirondacks of New York State and the Great Smokies of North Carolina. The purchase and reservation of this tract, which was advocated by leading scientific men and promoted by the Pennsylvania Forestry Association, had the support of the late Chief Forester F. A. Silcox, and was approved by the National Forest Reservation Commission in 1934. Its reservation is an important forward step in the U. S. Forest Service program of permanently preserving natural areas characteristic of native forest and range vegetation in all regions of the United States.

In administering this area the Forest Service recognizes two obligations. First, to preserve the native plant and animal life in its natural state in so far as this can be done on an area of this size, and, second, to allow the public to enjoy its unique qualities without jeopardizing their perpetuation. For this reason the area is divided into two parts; the northern portion, consisting of 2,018 acres and designated as the Tionesta Scenic Area, will be made accessible to the public by road and foot trails. Here the inspiration and true recreation to be found in a fairly large area of primeval forest may be enjoyed amid towering hemlock 300 to 500 years old and veteran beech 350 years of age. The southern portion, consisting of

2,113 acres and designated as the Tionesta Natural Area, is dedicated primarily to scientific research.

The report points out:

> This area is admirably suited for studying the response of the forest to climatic and biologic cycles, the development of the climax type, and the natural rejuvenation that results in the perpetuation of the climax. It is equally valuable for studying how completely the virgin forest supplies the life needs of the various animals found therein, and of how the forest with its multitude of different plant and animal forms influences the local climate, the soil and the regimen of streams. This natural area is in effect a primeval laboratory and as such it is open to all interested scientists for use. It is the desire of the Forest Service that full use be made of this tract as a center for research in forest and animal ecology.

Those who are interested may secure further information concerning the possibilities for research in this tract from the Allegheny Forest Experiment Station, Philadelphia.

EXPLORATION ON THE WEST AFRICAN COAST

GEORGE H. TATE, assistant curator of mammals of the American Museum of Natural History, has returned to New York after spending eighteen months in exploration and collecting in the rain forests of the West Coast of Africa.

In spite of torrential rains, once 14 inches in one day, the effects of the war in African colonies and a hurricane on his journey home, Dr. Tate has succeeded in bringing to the American Museum collections of more than 200 specimens, ranging from lemurs to pangolins. The main purpose of this expedition was to collect chimpanzees and mandrills, as well as foliage and other accessories for two new African Hall habitat groups. Dr. Tate was accompanied on part of the expedition by Robert Kane, artist and preparator of the staff of the museum.

Dr. Tate arrived at Tabou on the French Ivory Coast in April, 1939, and identified the chimpanzee habitat in the western part of the Ivory Coast, near the Liberian border. A collection was made in this region before the winter rains. The French Cameroons were next visited to obtain the mandrill apes that live in the dense tropical forests.

Three days after the arrival of the expedition at the port of Douala, war was declared in Europe, but in spite of the rigid wartime precautions that immediately went into effect, the French authorities allowed Dr. Tate to keep all hunting equipment. Soldiers were stationed at important points and road bridges, and it was necessary to show identification papers every few miles along the road.

Dr. Tate reports:

> In a region ten miles square, about half way between Kribi and Yaoundi, we located the mandrill bands and collected specimens for the Akeley African Hall group. We found that the mandrills traveled in large bands, numbering from 15 to 20 individuals and always led by an old male, larger and of the true mandrill coloring in red- and blue-skinned face. When danger approached, the band would scamper into the upper branches of the trees, while the old "head man" galloped away through the forest on the ground.
>
> Bad news came to us after the completion of this part of the expedition. Due to the rainy season, our collection of chimpanzee skins had arrived at the museum in New York unfit to mount as group specimens. We went back to the Ivory Coast to replace the first collection and found that we could not enter because our visas had expired. In the end, a second collection was obtained by going into Liberia and approaching the chimpanzee country at the Cavally River from the west, with headquarters at the Firestone plantation.

TECHNOCHEMICAL LECTURES AT THE MELLON INSTITUTE—1940–1941

A SERIES of fourteen lectures on the present condition of the American Chemical Industry will be presented by technologic specialists of Mellon Institute of Industrial Research during 1940–41. These discourses will be delivered on alternate Thursdays, in the fourth period (11:30 A.M.–12:30 P.M.), throughout both semesters, in the auditorium of the institute. They will be open to all students of industrial chemistry and chemical engineering in the University of Pittsburgh, as well as to the members of the faculty.

October 3. Dr. E. R. Weidlein, "Trends in the Chemical Industry."

October 17. Dr. F. W. Adams, "Development of the Manufacture of Heavy Chemicals."

October 31. Dr. B. G. Wilkes, "Some Industrial Products of Synthetic Organic Chemistry."

November 14. Dr. H. J. Rose, "Engineering Opportunities in Fuel Technology."

December 5. Dr. W. A. Gruse, "Progress through Research in Petroleum Technology."

January 2. Dr. R. L. Wakeman, "Engineering Opportunities in Plastics Technology."

January 16. Dr. F. L. Jones, "Optical Glass—A Key Industry."

February 20. Dr. H. E. Simpson, "Engineering Opportunities in Building Material Technology."

March 6. R. H. Heilman, "Engineering Importance of Heat-Insulating Materials."

March 20. Dr. G. H. Young, "Corrosion from the Engineering Standpoint."

April 3. Dr. R. C. Johnson, "Utilization of Some Mineral Wastes."

April 24. Dr. P. J. Wilson, Jr., "Progress through Research in Industrial Waste Disposal."

May 8. R. D. Hoak, "Industrial Stream Pollution Problems and Their Solution."

May 22. Dr. H. B. Meller, "The Important Place of Health in the Chemical Industry."

THE PROMOTION OF INTER-AMERICAN CULTURAL RELATIONS

UNDER the terms of the Convention for the Promotion of Inter-American Cultural Relations the United States has now arranged exchanges of students and professors with nine of the American republics. Ten graduate students from the other American republics have been selected for study in the United States and four additional students will soon be chosen. Eight graduate students and three professors from the United States have been invited to study and teach in other American countries. One of these is Dr. Carroll William Dodge, professor of botany at Washington University, St. Louis, who has been selected by the Government of Guatemala as exchange professor. These arrangements have been made between the United States and the Governments of Chile, Costa Rica, the Dominican Republic, Guatemala, Haiti, Nicaragua, Panama, Paraguay and Venezuela. In addition the United States has been informed that the Governments of Brazil and Peru will undertake similar arrangements in the near future. Plans for these exchanges have been worked out jointly by the Department of State and the Office of Education of the Federal Security Agency. In addition the Governments of Chile, Costa Rica, the Dominican Republic and Peru have indicated their desire to receive a professor from the United States and negotiations are now in process.

The present status of exchanges under the Convention for the Promotion of Inter-American Cultural Relations is therefore as follows:

The Government of *Brazil* has officially notified this government of its intention to inaugurate exchanges in the near future.

The Government of *Chile* has awarded fellowships to two American students and the Government of the United States has awarded fellowships to four Chilean students. Chile is also negotiating for an American professor.

The Government of *Costa Rica* has awarded fellowships to two U. S. students and the Government of the United States will shortly award two fellowships to Costa Rican students. Costa Rica is also negotiating for an American professor.

The Government of the *Dominican Republic* has awarded fellowships to two American students and the Government of the United States has awarded fellowships to two Dominican students. The Dominican Government is also negotiating for an American professor.

The Government of *Guatemala* has selected an American professor.

The Republic of *Haiti* has submitted a panel of students for consideration by the United States.

The Government of *Nicaragua* has selected an American professor and negotiations are in process for the exchange of students.

The Government of *Panama* has awarded a fellowship to an American student and the Government of the United States has awarded fellowships to two Panamanian students.

Fellowships have been awarded by the United States to two students from the Republic of *Paraguay*.

The Government of *Peru* has notified the United States that it will shortly initiate exchange arrangements.

The Government of *Venezuela* has selected an American professor, who is now in Venezuela, and has awarded a fellowship to an American student.

The Buenos Aires Convention was signed by each of twenty-one American Republics at the Inter-American Conference for the Maintenance of Peace held in Buenos Aires in 1936 and has been ratified by thirteen countries. The exchange program is directed toward the development of a more realistic understanding.

The expenses involved in the exchange program are shared by the participating governments. The nominating governments will pay the round trip travel costs of students together with other incidental expenses. The receiving government will pay tuition, subsidiary expenses and board and lodging at the institutions in which the visiting students are enrolled.

GRANTS IN AID OF RESEARCH

THE American Association for the Advancement of Science awards grants in aid of research at its annual meeting in December. Since the income from the association's permanent fund has never been great and is declining somewhat with decreasing rates of return from investment, the grants are necessarily small, rarely exceeding $250. Awards are often made to assist in completing investigations already under way or for supplementing funds available from other sources. There are, however, no established limitations on fields or purposes for which grants may be awarded.

Grants in aid of research are awarded upon the recommendation of the committee on grants, which consists of eight members, two elected each year by the council for a term of four years. The members of the committee on grants are chosen from among the various sciences so that every principal field of science is represented.

In order that applications for grants from the association may be examined and passed on by the committee on grants in time to make a report to the council at the meeting in Philadelphia in December, they must be filed in the office of the Permanent Secretary by November 10. After the applications are received they are mimeographed and copies of them are sent to each member of the committee on grants. Application forms and full instructions respecting the information that must be submitted will be furnished by the office of the Permanent Secretary, the Smithsonian Institution Building, Washington, D. C.

RECENT DEATHS

HARRY BURR FERRIS, since 1933 professor emeritus of anatomy of the School of Medicine of Yale University, died on October 12 at the age of seventy-five years. He had been a member of the faculty of the School of Medicine for forty-one years.

MORRIS B. CRAWFORD, professor emeritus of physics at Wesleyan University, who until his retirement in 1921 had been a member of the faculty for forty-four years, died on October 9. He was eighty-eight years old.

DR. CHARLES NICOLL BANCKER CAMAC, consulting physician of New York City, died on September 20 at the age of seventy-two years. He was from 1910 to 1937 assistant professor of clinical medicine at the College of Physicians and Surgeons, Columbia University.

DR. ALBERT BUELL LEWIS, curator of Melanesian ethnology at the Field Museum, Chicago, died on October 10 at the age of seventy-three years.

SIR WILFRED THOMASON GRENFELL, founder of the Labrador Medical Mission, died on October 9. He was seventy-five years old. Sir Wilfred was rector of St. Andrews University, Scotland, in 1929.

SIR ROBERT ABBOTT HADFIELD, London, metallurgist, the inventor of manganese and silicon steel and of other metallurgical improvements, died on September 30 at the age of eighty-one years.

DR. HENRY STROUD, emeritus professor of physics at the University of Durham, died on September 3 at the age of seventy-nine years.

DR. R. T. HEWLETT, emeritus professor of bacteriology at the University of London, died on September 10 at the age of seventy-five years.

DR. VITO VOLTERRA, formerly professor of mathematics at the University of Rome, died on October 11 at the age of eighty years.

DR. JULIUS WAGNER-JAUREGG, of the University of Vienna, who in 1927 was awarded a Nobel Prize for his work in the use of malaria and other fevers in treating syphilitic paralysis, died on October 1. He was eighty-three years old.

SCIENTIFIC NOTES AND NEWS

PROFESSOR GEORGE D. BIRKHOFF, Perkins professor of mathematics at Harvard University, has been elected a foreign associate of the National Academy of Sciences of Lima.

DR. WALTER B. CANNON, George Higginson professor of physiology at the Harvard Medical School, has been appointed Charles M. and Martha Hitchcock professor at the University of California for February, 1941.

DR. GUSTAV EGLOFF, director of research for the Universal Oil Products Company, has been awarded the Octave Chanute medal, given annually for the best paper on mechanical engineering read during the year before the Western Society of Engineers. The paper was entitled "Motor Fuels of the Present and the Future."

THE doctorate of laws was conferred at the autumn convocation of Queen's University, Kingston, Ontario, on Dr. J. B. Tyrrell, consulting mining engineer of Toronto, president of the Kirkland Lake Gold Mining Company.

The Experiment Station Record reports that, following service as agricultural adviser to the Government of Haiti, Dr. Atherton Lee, director of the Puerto Rico Federal Station, was tendered the decoration by the President of Haiti as an officer in the Legion of Honor and Merit of that country. Since his work in Haiti, Dr. Lee has served as agricultural adviser to the Governments of Ecuador and Colombia.

PROFESSOR LANCELOT HOGBEN, of the University of Aberdeen, author of "Mathematics for the Millions," has become for the present academic year a member of the faculty of the University of Wisconsin. He is giving a course on the history and significance of science, and is conducting a seminar in genetics.

ACCORDING to *Nature,* Dr. Ivor Jenning has been appointed principal of the University College of Ceylon, and Stanley A. A. Hammond educational adviser on the staff of the West Indian Comptroller.

DR. H. P. NEWSHOLME has resigned his professorship of public health in the University of Birmingham. Dr. G. A. Auden has been elected acting professor for the duration of the war.

DR. RICHARD J. LUND, editor of the *Mining Congress Journal,* has been made assistant group executive in the Mining and Mineral Products Division of the Advisory Commission to the Council of National Defense. He will coordinate work relating to a variety of minerals in the defense program. In this work he is closely associated with Dr. C. K. Leith, consultant on minerals to the commission, and with R. C. Allen, H. K. Masters, H. C. Sykes and E. Vogelsang, specialists on various strategic mineral commodities.

E. W. ENGSTROM, director of general research of the Radio Corporation of America Manufacturing Company, has been appointed manager of all research activities for the company.

DR. GANO DUNN, president of the J. G. White Engineering Corporation; Dr. David Sarnoff, president of the Radio Corporation of America, and Dr. Harry Woodburn Chase, president of New York University, are included among sixty-two leaders in the commercial, financial, educational, labor and other activities of New York City, who have been appointed by Mayor La Guardia, at the request of Governor Lehman, members of the Local Defense Committee.

DR. CARLYLE W. BENNETT, pathologist in the Division of Sugar Plant Investigations of the Bureau of Plant Industry, who is stationed at Riverside, Calif., sailed for Argentina on September 20 on a scientific mission of six months' duration. Dr. Bennett will investigate virus diseases of sugar beet as they occur in Argentina, giving special attention to the properties of the Argentine curly top known to exist in the Tucuman Province. The investigations will be conducted in collaboration with the Tucuman Experiment Station, and with the Ministry of Agriculture at Buenos Aires. Dr. Bennett expects to return to Riverside in March.

DR. DONALD K. TRESSLER, professor of agricultural chemistry at Cornell University, chief in research and head of the Division of Chemistry of the Agricultural Experiment Station at Geneva, has leave of absence this year in connection with research on the quick freezing of food products. He will visit fruit utilization plants on the Pacific coast, and will study the methods of freezing, canning and dehydrating, and use of by-products.

DURING the past summer Professor A. M. Bateman, a member of the department of geology of Yale University, investigated a deposit of asbestos in Venezuela; Professor R. F. Flint continued his study of glacial features in central Washington, to which he has devoted several earlier seasons; Professor and Mrs. A. Knopf resumed their work on the intrusion and the contact-metamorphic effects of the Boulder batholith, in the vicinity of Helena, Mont.; Dr. G. E. Lewis conducted an expedition to collect vertebrate fossils in parts of Montana, Wyoming, New Mexico and Colorado; Professor C. R. Longwell revisited localities in southern Nevada and western Arizona; George Switzer completed a field study of a problem involving glaucophane schist in the northern Coast Ranges of California. In January, 1941, Professor Longwell will return to Nevada and Arizona for several months of field work, chiefly in the Muddy Mountains and the southern part of the Virgin Mountains. John S. Shelton, instructor in the department last year, during the fall and winter will study and map the northern part of the Virgin Mountains.

DR. W. F. G. SWANN, director of the Bartol Research Foundation of the Franklin Institute at Swarthmore, Pa., gave an address on October 17 before the Washington Academy of Sciences entitled "The Laws of Nature."

DR. C. P. RHOADS, director of the Memorial Hospital for the Treatment of Cancer and Allied Diseases, New York, will address a joint meeting of the Institute of Medicine of Chicago and the Chicago Society of Internal Medicine on Monday evening, October 28, at the Palmer House. His subject will be "Physiological Aspects of Vitamin Deficiency."

PROFESSOR GREGORY PINCUS, of Clark University, gave an address entitled "The Developmental Physiology of Rabbit Eggs" before the Section of Biology of the New York Academy of Sciences on the evening of October 14.

As the outcome of a conference on the problems of maintaining pure genetic strains of animals and plants needed for laboratory studies in medicine, genetics and related fields the Division of Biology and Agriculture of the National Research Council has set up a committee charged with facilitating the maintenance of needed cultures of various groups of organisms, with the following members: L. T. Webster, *chairman;* M. Demerec, W. Landauer, E. Brand, R. A. Emerson, C. C. Little, Myron Gordon and P. W. Whiting. The committee will welcome information as to the problems of the maintenance of laboratory cultures in the fields which it covers.

AT the installation on October 25 and 26 of Dr. Howard Landis Bevis as seventh president of the Ohio State University, Dr. James Bryant Conant, of Harvard University, will be one of the speakers. The title of his address will be "The University and the Advancement of Learning." In connection with the installation on October 24 there are planned conferences on "The University and Agriculture," with Dean John F. Cunningham, of the Agricultural College, presiding, and on "The University and the Professions," with Chief Justice Carl V. Weygandt, of the Supreme Court of Ohio, as the presiding officer. Speakers at the agricultural conference will be Dr. Albert R. Mann, vice-president of the General Education Board, New York, and Dean Walter Coffey, of the College of Agriculture of the University of Minnesota. Dr. Roscoe Pound, dean emeritus of Harvard Law School, and Dr. Morris Fishbein, secretary and editor of the *Journal* of the American Medical Association, will speak at the conference on the professions.

ABSTRACTS for papers to be presented before the December meetings of Section I of the American Association for the Advancement of Science should be in the hands of the secretary of the section, Dr.

Leonard Carmichael, Tufts College, Massachusetts, by November 4. The abstracts should be about one hundred and fifty words.

THE issue of *Nature* for September 14 contains the following announcement: "For the time being the printing and publication of *Nature* may be delayed. Readers may be assured, however, that such delay, if any, will be kept to the minimum."

THE program of the meeting of the New York State section of the American Physical Society, which will be held at Syracuse University on October 26, includes a paper by Professor P. J. W. Debye, of Cornell University, on "The Influence of Atomic Motion on Interference Diagrams" and one by W. H. Carrier, entitled "Physics in Air Conditioning." On the previous evening Dr. Robley Evans, of the Massachusetts Institute of Technology, will deliver the Sigma Pi Sigma public lecture. He will speak on "Some Medical Applications of Nuclear Physics."

THE Society of Rheology meets at the American Museum of Natural History on October 18 and 19. Technical sessions were planned for both days. After the annual dinner on Friday evening Dr. Roy Waldo Miner, curator of living vertebrates at the museum, was expected to give a lecture entitled "Beneath the Seas for Museum Exhibits."

THE twentieth annual meeting of the Highway Research Board of the National Research Council will be held in Washington at the building of the National Academy of Sciences during the week beginning December 2. Sessions will be held on Wednesday, Thursday and Friday, December 4 to 6. According to the tentative schedule released by Roy W. Crum, director of the board, the Departments of Design, Materials and Construction, Maintenance, Economics and Soils and the Committee on Roadside Development will hold meetings on December 3 which will be open to the public. Board sessions will start on Wednesday morning, with the discussions centered about materials and soils investigations. On Wednesday afternoon topics relating to highway economics will be discussed; on Thursday morning, traffic; on Thursday afternoon, design and roadside development, and on Friday morning, finance and maintenance.

A SPECIAL dispatch to *The New York Times* states that the Pan American Convention on Nature Protection and Wild Life Preservation in the Western Hemisphere was signed at the Pan American Union on October 12 by the United States and six Latin American republics. Diplomatic representatives of Cuba, El Salvadore, Nicaragua, Peru, Venezuela and the Dominican Republic joined Cordell Hull, Secretary of State, in affixing their signatures. The new agreement would bind the signatories to create national parks, wilderness reserves and wild life sanctuaries in their territory. It is open for the signature of all other countries in the Western Hemisphere. The governments pledge themselves to preserve natural scenery, striking geological formations and regions containing objects of esthetic, scientific or historic interest. The convention also urges the granting of permits for the killing and capturing of certain species to scientific expeditions only.

IT has been announced that the 1941 convention of the American Association of Cereal Chemists will be held in Omaha, Nebr., from May 19 to May 23. R. M. Sandstedt, of the Nebraska Experiment Station, is chairman of the program committee. J. M. Doty, Omaha Grain Exchange, is chairman of the local committee. The officers of the association as elected at the recent New York convention are as follows: *President,* Claude F. Davis, Noblesville Milling Company, Ind.; *Vice-president,* Charles N. Frey, The Fleischmann Laboratories, New York; *Secretary,* Jim Doty, Omaha Grain Exchange Building; *Treasurer,* Perie Humold, Southwestern Milling Company, Kansas City, Kan.; *Editor-in-chief of Cereal Chemistry,* M. J. Blish, Berkeley, Calif.; *Managing Editor of Cereal Chemistry,* R. M. Sandstedt, Agricultural Experiment Station, Lincoln, Nebr.

THE "Graduate Fortnight" of the New York Academy of Medicine opened on October 14. The course consists of twenty-seven evening addresses on the origin, diagnosis and treatment of infections, involving the principal systems and organs of the body, with special reference to chemo-therapy. Clinics and clinical conferences are being held in twenty-one of the leading hospitals of the city. The scientific exhibit is at the New York Academy of Medicine. It includes items on the history of infections affecting various parts of the body. Dr. Malcolm Goodridge, president of the New York Academy of Medicine, gave the address of welcome on the evening of October 14 to visiting physicians and fellows of the academy.

IT is reported that the late William J. Wollman, securities broker, left a net estate of $7,233,926, of which a residuary estate of approximately $6,000,000 is left in trust for the benefit of his sister, Kate Wollman, the principal to be used after her death for "public, charitable, educational or scientific uses and purposes." The William J. Wollman Foundation was set up in 1938 for the purpose of administering this trust.

THE October number of *Current Geographical Publications,* issued by the American Geographical Society of New York, initiates a service of interest to geographers, teachers, writers and workers in many fields. Each number will have as a special supplement a

classified list of photographs contained in publications received in the American Geographical Society's library and indexed in its Photograph Catalogue. The Supplement is sent to all subscribers to *Current Geographical Publications* and can also be obtained separately.

DISCUSSION

THE SPAWNING MIGRATION OF THE SALMON

LITTLE is known concerning the factors guiding the migratory movements of the salmon. However, there are certain facts recognized by all workers in the field. (1) There are definite spawning grounds that are visited by specific species of salmon year after year. (2) Salmon runs have been established where no member of the species could ever have visited before being established.[1] (3) Salmon runs have been developed in virgin streams without having been planted. The best illustration is found in New Zealand, "Not a single individual of the quinnat species has ever been planted in a Canterbury stream, yet the Canterbury rivers now provide the best quinnat fishing in the Dominion, the species having migrated to their mouths from the Waitaki, where the original fry were planted."[1] (4) Efforts to establish salmon runs in certain other streams have failed. (5) Finally and most significant of all, repeated efforts to reestablish salmon runs in rivers now much modified which originally supported the particular species have failed. It is this last fact that has prompted me at this time to give a summary of my investigations on the physico-chemical behaviors of waters as factors in the spawning migration of the salmon, which in due time will be published in *Ecology*. No one doubts that there are regularly recurring cycles in the physiological activity of the salmon, of ocean currents and of physico-chemical conditions of the sea water and of waters of spawning streams that regulate and guide the migratory movements of the salmon. The controversy is over the cause or causes of these movements or the guiding force or factors and the details of the paths over which the salmon travel. Knowledge of these factors in conserving the salmon is of less vital importance so long as the conditions remain *in statu quo*. On the other hand, knowledge of these factors becomes of vital importance when we are faced with the possibility of profound changes in one or more of these regularly recurring chains of events by the building of reservoirs. If any link of the chain of events is broken or misplaced the salmon runs of that particular stream might possibly be doomed.

Carbon dioxide tension of the blood is known to have far-reaching effects upon the physiology of respiration of vertebrates including fishes. In mammals the carbon dioxide tension of the blood is nicely regulated by the rate of ventilation of the lungs. The author has shown in various researches that fishes must of necessity depend more upon the carbon dioxide tension of the water to regulate the carbon dioxide tension of the blood. In view of these facts and the additional fact that volume of stream flow facilitates salmon runs into spawning streams I decided to determine the effect of different mixtures of fresh and sea waters upon the carbon dioxide tension of the mixtures.

The following is a summary of this investigation. It was found that the carbon dioxide holding capacity of a mixture of fresh water with a low alkalinity, and of sea water was always greater than the sum of the carbon dioxide holding capacities of the two waters before they were mixed. This simply means that the carbon dioxide tension of the mixture, without addition or loss of carbon dioxide, is always less than the carbon dioxide tension of the two waters before they were mixed. The lower the alkalinity of the fresh water the greater the reduction of the carbon dioxide tension of the mixture. On the other hand, the higher the alkalinity of the fresh water the less the reduction of the carbon dioxide tension of the mixture. With a very high alkaline fresh water the reduction is nil. It was also found that the increase in the carbon dioxide holding capacity of a mixed fresh water and sea water is greater in the high fresh water-sea water ratios than in the lower ratios and the very high ratios. In other words, there is a peak in the increase in the carbon dioxide holding capacity of mixed fresh and sea waters at high fresh water-sea water ratios. This increase is reduced rapidly as the ratios increase and less rapidly as the ratios are decreased.

The mixing of fresh water from the rivers, spawning streams, with the sea water of the ocean is an ever continuous process. Since the lowering of the carbon dioxide tension is greater in the higher fresh water-lower sea water mixtures than in the lower fresh water-higher sea water mixtures there is an uphill gradient of carbon dioxide tension of the water from near the mouths of rivers out into the ocean as far as there is a fresh water-sea water mixture. There is still another fundamental fact. Just as soon as the carbon dioxide tension of a fresh water-sea water mixture is lowered below the carbon dioxide partial pressure of the atmosphere carbon dioxide will be taken up from the atmosphere by the fresh water-sea water mixture. With a further concentration of sea water

[1] F. A. Davidson and S. T. Hutchenson, *U. S. Dept. Com., Bur. Fish., Bull.* 26: 667–692, 1938.

it can be shown mathematically that the carbon dioxide tension of the more concentrated sea water would then be higher than the carbon dioxide partial pressure of the atmosphere. This would form a "ridge" or "peak" of high carbon dioxide tension water on the outer edge of the diluted sea water. There would then be a carbon dioxide tension gradient from the mouths of rivers out to the extent of their diluting influence into the ocean. This area would in turn be bounded by waters having carbon dioxide tensions higher than the carbon dioxide partial pressure of the atmosphere.

The question is now raised, do fishes respond to a gradient of carbon dioxide tension water? Researches that have been carried on indicate that fishes do respond to a carbon dioxide tension gradient. Brilliant work done in the field of mammalian physiology has shown that the carotid bodies are sensitive, though to a less extent than the respiratory center, to a change in carbon dioxide tension of the blood. The carotid bodies alone are responsive to low oxygen tension of the blood. It is a well-known fact among all biologists that fishes avoid the high carbon dioxide tension and low oxygen tension hypolimnion water of a stratified lake. Now going back to our area of sea bounded by a "ridge" of high carbon dioxide tension it is obvious that if a salmon should cross this ridge it would be in an area dominated by another river and would be a stray (see discussion that follows).

It is a well-known fact that there is an increase in protein metabolism in the salmon when approaching sexual maturity. Increased protein metabolism tends toward acidosis, *i.e.*, a lowering of the alkali level of the blood. It is suggested that this lower alkali level of the blood brings about a response to a lower carbon dioxide tension of the water. At first this might constitute a drift, wandering, that would carry the salmon that were approaching sexual maturity, but not the immature, into lower carbon dioxide tension water. The carbon dioxide tension gradient is still steeper in the lower carbon dioxide tension water. The protein metabolism of the salmon is further increased as it approaches nearer sexual maturity. This still lower alkali level of the blood increases the response to lower carbon dioxide tension water which is more effective since there is an increased carbon dioxide tension gradient. The salmon finds the spawning streams by following the carbon dioxide tension gradient. The steeper the gradient, *i.e.*, the greater the volume flow of the stream, and the nearer the approach to sexual maturity the more vigorous the response of the salmon. When the salmon reach the mouth of the river they respond to current and ascend the spawning stream.

These suggested behaviors of the salmon are in complete accord with all known facts concerning the migratory movements of the salmon. It also explains why the immature salmon do not enter rivers *en masse*. The cycle is physiological, sexual and less environmental, seasonal. Of course we all understand that all physiological and sexual cycles are tied up with the environment, *i.e.*, seasonal.

The spawning ground chosen is a matter of reactions to environmental factors.[2]

These views are in keeping with Huntsman's[3] findings that salmon are held within the influence of natal streams, the "parent stream" theory and the specific races of the European workers. These are all discussed in the forthcoming paper. The author is well aware that much detail remains yet to be worked out. The author also wishes to emphasize the fact that no one factor can be responsible for all migratory movements of salmon.

EDWIN B. POWERS

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THE PERIODIC DIE-OFF IN CERTAIN HERBIVOROUS MAMMALS AND BIRDS

GREEN and others[1,2] have recently found that the cyclic decline of hares (*L. americanus*) in Canada is due in the main to a non-infectious disease which they call shock disease. The animals die suddenly in convulsions from a hypoglycaemic shock, due to degeneration of the liver with resultant failure of glycogen storage. The authors surmise that a similar disease may account for the four-year cycle in mice, since similar symptoms have been noted in these animals without any infectious agent being demonstrable. The cause of this liver damage in *L. americanus* has not been found, but several explanations are suggested, one of them being that "the increasing population may eradicate certain plants that contain food elements essential for the maintenance of healthy populations."

Now, there are some peculiarities in the behavior of the animals which do suggest deficiencies in the food, more specially mineral deficiency. The Danish civil engineer, Mr. J. O. B. Petersen, who has been working for several years in the northern parts of the Canadian forests, told me that "the rabbits" during their peak in numbers were very eager to gnaw or lick at anything which had been touched by sweaty hands; they could even be a nuisance in attacking measuring instruments, etc. This was not observed at other times; it was even possible to know whether a thrown-away boot had been lying in the forest since the last maximum, since in that case the sole would be gnawed away by the hares. As a matter of fact this behavior has been recorded (as a curiosity) by Soper,[3] who during

[2] E. B. Powers, Publ. Amer. Assoc. Adv. Sci., No. 8: 72–85 and citations, and H. B. Ward, Publ. Amer. Assoc. Adv. Sci., No. 8: 60–71.

[3] A. G. Huntsman, SCIENCE, 85: 582–583, 1937.

[1] R. G. Green and C. L. Larson, *Amer. Jour. Hyg.*, Baltimore, 28: 190, 1938.

[2] R. G. Green, C. L. Larson and J. F. Bell, *Amer. Jour. Hyg.*, Baltimore, 30: 99, 1939.

a period of maximum abundance observed from traces in the snow how the animals had assembled in the night, nosing up to "every conspicuous object about camp—the water pail, axe, overturned boots, etc." The occasional carnivorous habits also referred to by Soper would seem to be restricted—at least mostly—to years of maximum abundance. Many other cases of depraved appetite in herbivorous mammals could be cited. Jacobi,[4] in his monograph of the reindeer, has brought together many interesting instances. We are concerned here with symptoms known to indicate mineral deficiency. It is not necessary to look for special food plants, the lack of which may bring about fatal results, because most plants are known to vary enormously as to minerals.[5] To veterinarians it is a familiar fact that serious diseases may result from deficiencies of minerals in pasture, and there is no reason why wild animals living on the same food should not be affected in a similar way. While, to judge from cattle pathology, the lack of certain "trace" elements (Cu., Co) occurs in restricted areas only, it appears that deficiencies affecting the acid-base balance are sufficiently wide-spread to account for the sudden drop in health observed in herbivorous mammals and birds at certain times. As an instance of such diseases in cattle may be mentioned licking disease, the name of which is derived from symptoms strikingly similar to those referred to above; even liver damage has been observed.[6] It is caused by a deficit of K (and Na) in proportion to the sulfuric and hydrochloric acids formed when the grass is digested. The enormous variations in this proportion found from year to year[7] are dependent on bacterial processes in the soil, and these in turn are said to be influenced to some extent by climate.[8] On the whole, climatic conditions appear to be one of the set of factors influencing the mineral contents of plants, and moreover the various elements are not affected alike.[9] It may be possible therefore to account for the regularity of the cycles in numbers by oscillations in the biological and chemical processes in the soil regulated by or adjusted to climatic cycles.

While it is true that the ten-year cycle in hares, ruffed grouse, etc., can not be correlated with sunspots,[10] a well-marked climatic oscillation of the same average length seems, nevertheless, to exist,[11,12] and parallels to the cycles of four years in mice, and six years in red grouse[13] and crossbills,[14] are also found in meteorological literature.[15,16] These climatic cycles may need further confirmation, but their close agreement as to length with the biological ones, in spite of the fact that in most cases these have been unknown to the authors, strongly suggests that they are real. Elton's[17] theory that the fluctuations in numbers are caused by meteorological cycles seems so far confirmed, but there is probably general agreement to-day that it is impossible to explain the phenomenon by *direct* climatic influence on the animals, as was at first supposed.

F. W. BRAESTRŬP

ZOOLOGISK MUSEUM,
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PURIFICATION OF THE PITUITARY INTERSTITIAL CELL STIMULATING HORMONE[1]

THE paper by Shedlovsky, Rothen, Greep, van Dyke and Chow[2] on "The Isolation in Pure Form of the Interstitial Cell-stimulating (Luteinizing) Hormone of the Anterior Lobe of the Pituitary Gland" reports results in such contrast with those found in our own laboratory[3] that we consider it important to emphasize these differences.

Both papers describe the preparation of an apparently pure protein with similar biological properties, the minimal effective dose (MED) also happening to be the same. The evidence for belief in the purity of the substance herein reported is as follows:

1. *Specificity of biological behavior.* The substance has a specific effect on the ovary and testis of hypophysectomized immature rats—the repair of the interstitial cells. When injected intraperitoneally into normal immature female rats, it reduces the potency of certain concordantly administered gonadotrophins (pregnant male serum and chorionic gonadotrophin). When injected into hypophysectomized immature males, it stimulates the accessory organs of reproduc-

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[1] Aided by grants from the Board of Research of the University of California, from The Rockefeller Foundation and from Parke, Davis Company. Assistance was rendered by the Works Progress Administration, Project No. OP 665–08–3–30, Unit A–5.

[2] SCIENCE, 92: 178, 1940.
[3] C. H. Li, M. E. Simpson and H. M. Evans. "The Interstitial Cell Stimulating Hormone. II. Method of Preparation and Some Physico-chemical Studies." *Endocrinology*, in press.

tion. (In some strains, the stimulation is more limited than in others.) It augments the potency of the follicle-stimulating hormone (FSH) judged either by increase in follicular development or in uterine weights. It is to be emphasized that one half unit or 0.0025 mg of the substance, when combined with 2 RU of FSH, doubles the uterine weight in immature hypophysectomized rats. Shedlovsky *et al.* do not report tests essential for establishing the freedom of their material from contamination with other hormones of the anterior hypophysis. The substance herein reported is free of follicle-stimulating effects when given in 600-fold the MED for repair of the interstitial tissue; no thyrotrophic hormone was detected at the 0.50 mgm level in the one-day-old chick thyroid weight test; no growth-promoting activity or adrenocorticotrophic effect was detected in hypophysectomized rats when injected at a total dose of 8 mg in 10 days; the local crop test for lactogenic hormone was negative at 0.68 mgm.

2. *Chemical characteristics.* The protein contained 14.2 per cent. of nitrogen with approximately 4.5 per cent. of tyrosine and 1 per cent. of tryptophane. The carbohydrate content remained constant on repeated ammonium sulfate fractionation; analysis showed 4.45 per cent. mannose and 5.86 per cent. glucosamine.

3. *Physical study* (cataphoresis) has indicated the homogeneity of the protein. The schlieren picture obtained in the Tiselius apparatus showed only one boundary by scanning the whole field after electrolysis for 90 minutes. The mobility of the protein was found to be -6.36×10^{-5} in phosphate buffer of pH 7.53 and ionic strength 0.05 at 1.5° C. Electrophoresis experiments showed the isoelectric point to lie between pH 4.6 – 4.8. It is to be noted that in contrast with our results, Shedlovsky *et al.* obtained a mobility of 0.66×10^{-5} at pH = 7.86 and an isoelectric point of pH 7.45. It may therefore be said that although proteins with similar biological properties have been isolated by two laboratories, the results from electrophoretic study are so different as to forbid identification of the substances in question.

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THE BLACKENING OF COOKED POTATOES

THE blackening of cooked potatoes is a different process from the darkening that occurs when raw peeled potatoes are exposed to air; the latter darkening is known to be due to melanin. Although both darkening processes are oxidations, the synthesis of melanin involves an enzyme whereas the other type does not require one. Potatoes which did not darken when kept in an atmosphere of nitrogen during boiling and cooling blackened when removed to the air.

Certain properties, including the ultraviolet absorption spectra of the pigments from the darkened raw and cooked potatoes, were compared. Those of the blackened cooked portions differed markedly from the melanin and, moreover, showed properties similar to flavones.

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SCIENTIFIC BOOKS

CATASTROPHISM VERSUS EVOLUTIONISM

The Material Basis of Evolution. By RICHARD GOLDSCHMIDT. 436 pp. New Haven: Yale University Press. 1940. Price $5.00.

THIS book contains the only basically new theory of organic transformation propounded during the current century. For notwithstanding the colossal literature concerning organic evolution which has accumulated since the publication of Darwin's "Origin of Species," only three main types of theories can be distinguished. One type is based on Lamarck's assumption of direct adaptation by inheritance of results of use or disuse of parts. Other theories are built on Darwin's principle of natural selection of the fittest variants produced by interactions of the organism's inherited structure with the external as well as internal environments. Theories of the third group assume autogenesis, that is, unfolding of the potentialities hidden in the organism, impelled by an urge toward development in a certain direction. According to all these theories organic transformation takes place by evolution, that is, gradually by accretion of more or less small changes. According to Goldschmidt, however, it occurs by cataclysmic upheavals rather than by summation of individually small steps.

Lamarckianism has become obsolete owing to its basic assumption having fallen short of experimental verification. Autogenesis has always been in conflict with the principle of causality in vogue in the materialistically-minded modern science. Darwinism underwent great changes because of the forward strides of genetics, but the unbroken continuity of ideas between the "neo-Darwinism" and Darwin's original theory is evident. The appearance of Goldschmidt's book connotes an at least temporary end of the undivided reign of neo-Darwinian theories. For Goldschmidt not only relegates natural selection to a place

of relative unimportance, but in effect rejects evolution beyond the narrow confines in which it has been admitted to exist by Linnaeus and many creationists. His theory belongs to the realm of catastrophism, not to that of evolutionism; his break with the Darwinian tradition is almost complete, and his ideas are related to those of G. St. Hilaire rather than to those of any modern evolutionist. Only deVries has occasionally expressed himself in a language similar to Goldschmidt's, but this similarity proves to be a spurious one. Genetics has been considered the foundation of neo-Darwinism. Throughout his book Goldschmidt stresses the fact that his views are a result of his lifelong work in genetics, but it must not be forgotten that he has a splendid command of other biological disciplines as well. Goldschmidt's interpretation of genetic data is different from the rather generally accepted one.

Only the salient points of Goldschmidt's brilliantly developed and masterfully presented theory can be summarized here. Goldschmidt asserts a fundamental dualism of the processes of organic transformation by distinguishing microevolutionary and macroevolutionary changes. 'Microevolution by accumulation of micromutations—we may also say neo-Darwinian evolution—is a process which leads to diversification strictly within a species, usually, if not exclusively, for the sake of adaptation of the species to specific conditions within the area which it is able to occupy." This process has nothing to do with the origin of new species: 'the subspecies are diversifications within the species, but there is no reason to regard them as incipient species." On the other hand, "the change from species to species is not a change involving more and more atomistic changes, but a complete change of the primary pattern or reaction system into a new one. . . . One might call this different type of genetic change a systemic mutation. . . ." The effectiveness of systemic mutations is tremendous: "Macroevolution may proceed by large and sudden steps which accomplish at once what small accumulations can not perfect in eons, and this on the specific as well as on any higher level." "Species and the higher categories originate in single macroevolutionary steps as completely new genetic systems." The origin of mimetic resemblances, of mutual adaptations of flowers and insects, the transformation of *Sinanthropus* into *Homo sapiens* might have taken place thus suddenly. The bon mot of Schindewolf that "the first bird hatched from a reptilian egg" is quoted approvingly, although it is not clear to the reviewer whether Goldschmidt intends this to be taken literally. The role of natural selection in macroevolution "becomes reduced to the simple alternative: immediate acceptance or rejection."

Although, in the reviewer's opinion, Goldschmidt's theory is invalid, it must be admitted that Goldschmidt has marshalled an impressive array of evidence in its favor. If races are not incipient species, if species arise by changes akin to explosions, the living world must be divisible into discrete species compartments. The lack of universality of such rigid subdivisions is what has ever since Darwin been one of the main arguments in favor of evolution. The first 183 pages of Goldschmidt's book are devoted to disproving this argument. The alleged transitional cases between races and species are scorchingly criticized and shown, according to the author, to be spurious. He admits that there are transitions between some of the "species" of the taxonomists, but these are not deemed to be real species. Goldschmidt has no crusading zeal to induce taxonomists to abandon their errors, but he insists that to an evolutionist "Where species can be distinguished with certainty . . . they are different and are separated by a gap, if not by an abyss." However, no definition of what a real species should be is given, so that one is left wondering how to detect them in practice.

Pages 184–250 contain the climax of Goldschmidt's theory: the statement of the case for systemic mutations. "A systemic mutation (or a series of such), then, consists of a change of intrachromosomal pattern," and involves "only the arrangement of the serial chemical constituents of the chromosomes into a new, spatially different order. . . ." An excellent review of the data showing that species differ in the linear sequence of materials (gene arrangement) in the chromosomes is given, and the conclusion is reached that the source of macroevolutionary changes is herein detected. A thorny question obtrudes, however, in the reviewer's mind. According to Goldschmidt, genes do not exist, and what has been known as gene mutation (the microevolutionary one!) is based on very small pattern changes in the chromosomes. What, then, is the fundamental difference between the ordinary mutations and systemic mutations?

Next (pp. 250–395), follows the chapter on "Evolution and the potentialities of development," in which Goldschmidt seeks to prove that the normal embryogeny contains potentialities which, when evoked by a genetic change, may lead to a complete reorganization of the end product. Here Goldschmidt is really at his best: pertinent facts from experimental embryology, comparative anatomy and physiology, unknown to or ignored by many geneticists, are organized into a logical and convincing system. It is difficult not to agree with Goldschmidt's conclusion that "The physiological balanced system of development is such that in many cases a single upset leads automatically to a whole series of consecutive changes of development. . . . If the result is not, as it fre-

quently is, a monstrosity incapable of completing development and surviving, a completely new anatomical construction may emerge in one step from such a change." Whether or not the production of such "hopeful monsters" may reasonably be considered the main channel of organic transformation is, however, an entirely different matter, as Goldschmidt himself admits (p. 251).

It is impossible to attempt here a critique of Goldschmidt's theory, for this would require a book approximately of the same size as his own. Certain lines which such a criticism might take are adumbrated above. In his concluding chapter (pp. 396–399), Goldschmidt indicates that one of the advantages of his views over neo-Darwinism is the simplicity of the former. It is indeed simpler to assume that major groups of organisms arose ready-made by catastrophic systemic mutations than to visualize the complex interplay of the numerous agents which could bring similar results on the neo-Darwinian scheme. But in the reviewer's opinion the simplicity of Goldschmidt's theory is that of a belief in miracles. It must, nevertheless, be recognized that Goldschmidt's keenly critical analysis has emphasized the weaknesses and deficiencies of the neo-Darwinian conception of evolution, which are numerous, as even partisans ought to have the courage to admit. It would seem that this fact alone obliges any one interested in the modern evolutionary thought to read Goldschmidt's book.

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REPORTS

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND THE NATIONAL DEFENSE PROGRAM[1]

PROTECTION of the Western Hemisphere and especially of the North American continent against any possible invasion by force is the firm determination of all true Americans. Equally important, and more difficult, is defense of the freedom of spirit and action which our forefathers won for us by generations of struggle and which is stealthily threatened alike by subversive influences from without and vicious ambitions from within. Both tend to undermine our strength by sowing doubt and discord. Sometimes these influences operate insidiously in the guise of high idealism, as in the cause of peace or of human rights; sometimes they operate openly to incite violence and class hatred.

Research work on national defense problems is being conducted in many of the departments of the institute. Most of this is through contracts with the War and Navy Departments, the National Advisory Committee for Aeronatuics, the National Defense Research Committee, the National Academy of Sciences and with private companies engaged in development of equipment for military purposes.

Members of the institute's staff are serving in a variety of national defense agencies, some having been granted leaves of absence and others having been relieved of a portion of their institute duties to make this possible. Dr. Robert G. Caldwell, dean of humanities, is serving as chairman of the Division of Cultural Relations Among the American Republics, a post he has taken at the request of President Roosevelt. Professor Ralph D. Bennett, of the department of electrical engineering; Professor Francis Bitter, of the department of metallurgy, and Doyle Northrup, of the department of physics, are on leave of absence to carry on an important research program for the Navy Department, while Professor C. M. Van Atta and R. D. Campbell resigned from the physics staff to work on this project.

Professor Jerome C. Hunsaker, head of the departments of mechanical engineering and aeronautical engineering, is a member of the National Advisory Committee for Aeronautics, and is participating in the aeronautical research programs conducted for the Army and Navy by that committee. Through membership in many other boards and committees in Washington he is also aiding the defense program. Professor Walter G. Whitman, head of the department of chemical engineering, is chairman of a subcommittee of the National Advisory Committee for Aeronautics. Professor E. S. Taylor, of the department of aeronautical engineering, has been the chief assistant to George J. Mead, a graduate of the institute, who is in charge of airplane engine production under Mr. Knudsen, head of the National Defense Committee.

Professor John E. Burchard, director of the Bemis Foundation of Technology, is in active charge of a group of scientists and engineers charged with the development of special types of shelters.

Professor Douglass V. Brown is head of the Division of Economics and Statistics for the Stettinius Committee, and his colleague, Professor Douglas M. McGregor, has been called from time to time to undertake special assignments for the Bureau of Labor Statistics.

The National Defense Research Committee, under the chairmanship of our colleague, Dr. Vannevar

[1] From the annual report of President Karl T. Compton to the Corporation of the Massachusetts Institute of Technology.

Bush, formerly vice-president and dean of engineering at the Massachusetts Institute of Technology, has presently available a large fund for research on devices and instruments of warfare. Members of the committee in charge of its four divisions are Dr. Frank B. Jewett (M. I. T., '03), Dr. Richard C. Tolman (M. I. T., '03), President James B. Conant, of Harvard University and myself. Among the committee's section chairmen are Dr. Alfred L. Loomis, of the corporation; Professor W. K. Lewis, department of chemical engineering, and Professor George R. Harrison, department of physics, and on the operating section committees are Professors Tenney L. Davis, chemistry department; Thomas K. Sherwood, chemical engineering department; Edward L. Bowles and Samuel H. Caldwell, both of the electrical engineering department.

These are only some of the present national defense activities of our staff. Many others also will undoubtedly arise in the near future.

Where we possess facilities of personnel or equipment which can contribute in especially significant ways to the national defense program, we should direct them to this effort, always guided by our best evaluation of the national importance of this effort in comparison with other ways in which these same personnel and facilities might be used. We should make this possible by postponing less urgent research projects, by internal rearrangement of teaching schedules and by carrying a more than normal per capita burden of work.

In addition to scientific and engineering research, special courses in various scientific fields have been given and others are expected to follow as the need arises. One of these was an intensive course for junior aeronautical engineers. Fifty-one graduates in civil, mechanical and other engineering subjects from engineering schools in northeastern United States were accepted for this ten weeks' course without tuition. The success of the program has led to requests by aircraft companies that the course be repeated and that similar training be offered in other fields. Congress has under consideration an appropriation of $9,000,000 for financing short intensive courses in engineering schools.

Technology is continuing to participate in the Civilian Pilot Training program and is planning to speed up the ground school program during the current academic year.

Weather forecasting is an essential feature of modern warfare. For a number of years the institute has been giving postgraduate training in meteorology to young men of the Army, Navy and the United States Weather Bureau. This summer a special intensive course was given to recruits for the meteorological service of the Army Air Corps. During the current academic year, training will be given to another group of approximately sixty-five special postgraduate students in this subject, mostly from the Army Air Corps and the Weather Bureau. With these additions we have had a threefold increase in the number of graduate students studying meteorology.

Realizing fully that present conditions make it more important than ever that it keep abreast of advances in science and engineering and that its officers must have the best possible technical training, the Navy Department is sending an increased number of officers for postgraduate study at the institute. At its request there has been established a new course which combines the separate courses in naval construction and naval engineering into a single coordinated program. Of the sixty officers detailed to technology, forty are taking this three-year program and the remainder are distributed among other courses.

As the need arises we are preparing to institute intensive new courses in naval construction and aircraft instruments for special groups of officers.

The Wright Brothers Memorial Wind Tunnel is in continuous and overtime use for the testing of design models of new types of airplanes. With funds provided by two aircraft companies, important new equipment is being added to this laboratory to permit tests on models with power applied to propellers, thus more closely simulating flight conditions.

SPECIAL ARTICLES

PROPERTIES OF THE ISOLATED EQUINE ENCEPHALOMYELITIS VIRUS (EASTERN STRAIN)[1]

REPORTS from this laboratory during the past two years have been concerned with the purification of the virus of equine encephalomyelitis and the study of its properties. Of chief interest has been the investigation of a specific material obtained by ultracentrifugal fractionation of extracts of chick embryos diseased with the virus (Eastern strain). With this material, first described by Wyckoff,[2] is associated the infectivity of the extracts from which it is derived. Continued study has provided increasing evidence that it is identical with the virus.

The process consistently yielding the purified virus

[1] This work was aided by grants from Lederle Laboratories, Pearl River, N. Y., and the Dorothy Beard Research Fund.

[2] R. W. G. Wyckoff, *Proc. Soc. Exp. Biol. and Med.*, 36: 771, 1937.

has already been described.[3] Obtained after three cycles of alternate low- and high-speed ultracentrifugation, the purified substance, dissolved in solution of 0.1 M or greater salt concentration, exhibits the homogeneity of a single molecular species[3] in the analytical ultracentrifuge. The sedimenting boundary is sharp, comparable with the boundaries seen with the papilloma virus[4] and reported for the tobacco ringspot virus[5] though not with those of certain other plant viruses such as that of tobacco mosaic. Unsedimentable light-absorbing substances are not present nor are more than traces of material sedimenting more rapidly than the virus. The sedimentation constant is $S_{20^\circ} = 253 \times 10^{-13}$ cm sec^{-1} dynes^{-1}.

Solutions containing 0.1 per cent. virus are opalescent and give the usual protein tests. The Molisch test is initially negative, but positive tests for pentose with orcinol and sulfuric acid and Bial's reagent are obtained. The Schiff test for aldehydes is strongly positive and so, too, is the acrolein test for fat. A sample containing 0.25 per cent. virus heated gradually (2° per minute) becomes opaque at 56.0 to 58.0° C. The denatured material is insoluble, its initial infectivity is lost, and the nitroprusside test is negative. Dialysis against distilled water leads to precipitation and partial inactivation of the virus, and the salt-free material frozen and dried *in vacuo* is further inactivated and insoluble in saline solutions.

The results of chemical fractionation and analysis are summarized in Table 1. For this about 300 mg of the homogeneous material with an initial infectivity of about 10^{14} mouse infectious units per gram was dialyzed against distilled water, frozen and dried *in vacuo* and then dried to constant weight over P_2O_5. The lipoid fraction was obtained by extraction in turn with acetone, alcohol-ether (1–1) and benzene. From a solution of the whole lipoid fraction in chloroform, phospholipids were precipitated with strontium chloride and acetone.[6] The precipitate was completely soluble in moist ether and contained practically all the nitrogen and phosphorus of the whole lipoid fraction. The weight of this phospholipid subfraction was calculated from the phosphorus value with the factor 26. Cholesterol was determined upon an aliquot of the acetone fraction and was completely precipitable with digitonin. Fatty acid was calculated as oleic acid. The presence of aldehydes in the lipoid fraction was indicated by a strongly positive test with Schiff's reagent.

TABLE 1

FRACTIONATION AND ANALYSIS OF THE EQUINE ENCEPHALOMYELITIS VIRUS (EASTERN STRAIN)

	Whole virus	Virus fractions							
		Lipoid				Carbohydrate†	Protein		Yeast nucleic acid
		Total	Phospholipid	Cholesterol	Fatty acid	Total	Total	Nucleic acid	
Per cent. of whole virus		54.1*	35	13.8	9.6	4.0	49.1*	4.4	
Per cent. of fraction			64	24.0	18.0			9.6	
C (per cent. dry weight)	62.2								
H " "	9.2								
N " "	7.7	1.5	2.0				14.1	14.1	13.3
P " "	2.2	2.4	2.5				1.2	7.3	7.9
Residue " "	2.8								
Carbohydrate† " "	4.0	1.6					7.2	33.6	33.2
N : P	3.6 : 1	1 : 1.6	1 : 1.2				1 : 11.7	1 : 1.9	1 : 1.7
Carbohydrate : P	1.8 : 1	1 : 1.5					6 : 1	4.6 : 1	4.3 : 1

* These values include the corresponding fraction of total carbohydrate.
† Carbohydrate as glucose.

The protein fraction remaining after lipoid extraction gave positive tests for pentoses and only a weakly positive Schiff test. From 57.5 mg of the protein fraction, 5.5 mg of material having the qualitative solubility and general properties of a ribose nucleic acid was obtained.[7] Practically all the phosphorus was removed from the protein in this subfraction. Samples weighing 0.25 to 0.3 mg gave positive orcinol and Bial tests, but were negative with the Feulgen test. Parallel tests and analyses were made with comparable weights of yeast and thymus nucleic acids. It is evident that the behavior and constitution of this virus nucleic acid are similar to those of yeast nucleic acid.

By pyknometer measurements on solutions of fully

[3] A. R. Taylor, D. G. Sharp, H. Finkelstein and J. W. Beard, *Proc. Soc. Exp. Biol. and Med.*, 43: 648, 1940.

[4] J. W. Beard, W. R. Bryan and R. W. G. Wyckoff, *Jour. Infect. Dis.*, 65: 43, 1939.

[5] W. M. Stanley, *Jour. Biol. Chem.*, 129: 405, 1939.

[6] R. J. Reiser, *Jour. Biol. Chem.*, 120: 625, 1937. We are greatly indebted to Dr. Reiser for his advice and aid in the analysis of the lipoid fraction.

[7] T. B. Johnson and H. Harkins, *Jour. Am. Chem. Soc.*, 51: 1770, 1929.

active virus the partial specific volume was 0.839, corresponding to a specific gravity of 1.19.

Molecular stability[8] is at a maximum between pH 7.0 and 8.5. When the pH is reduced below about 6.5, the virus precipitates, and its infectivity is rapidly lost.[9] Disintegration, occurring slowly in the optimum pH range and more rapidly above the optimum to about pH 10.5, takes place as a splitting off of relatively very small light-absorbing fragments. These fragments are evident in the sedimentation patterns above the still sharp boundary of the residual virus, which thus becomes progressively obscured. At pH levels above about 10.5, the sedimentation constant of the residual large component is greatly diminished. Exposure of the virus to ultraviolet light of 2537 Å results in inactivation at a rate of the same order of magnitude as that reported for certain bacteria.[10] Virus inactivated in this way to the extent of 7 decimal dilutions gives a slightly diffuse sedimentation boundary and the same sedimentation constant as that of the fully active material. The molecular stability of the inactive material is much less than that of the untreated virus, but the process of disintegration subsequent to irradiation appears similar to that of the intact virus. The nitroprusside test of the inactive material is negative.

The purified material studied is specific to the virus-diseased chick embryos. No trace of a similar or related component has been found in repeated studies of normal embryo tissue. The homogeneity of the product is clearly evident in the findings with the analytical ultracentrifuge and in the uniformity of its biological and chemical behavior. It would thus appear that the virus of equine encephalomyelitis (Eastern strain) is a complex of high molecular weight consisting of phospholipids, cholesterol, fatty acid and ribonucleoprotein.

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HYPERFUNCTION OF ANTERIOR PITUITARY IN RATS. II. ESTRUS CYCLES[1]

IN previous papers[2,3] the authors have reported the following as evidence of a hyperactivity of the anterior pituitary in their colony of the Yale strain of rats: (1) high fasting blood sugar, (2) low glucose tolerance, (3) an exaggerated hyperglycemic response to epinephrine, (4) an initial resistance to insulin, (5) a high percentage of body fat, (6) an exaggerated rate of growth and adult size, (7) large urine volume and (8) high incidence of sterility. If these characteristics result from a hyperfunction of the anterior pituitary, one might expect to find a reflection of this activity in the estrus cycle.

Observations on 122 rats revealed a significant difference between the cycles of the Yale strain and the normal strain, although quantitatively the difference was not as great as that observed by Evans[4] following the injection of anterior pituitary extracts. The procedure consisted of comparing under controlled conditions the estrus cycles of the Yale strain with those of the Wistar strain which we consider normal for reasons previously enumerated.[2,3] Individuals from the two strains were matched according to age, type of cage, number per cage, degree of light exposure and diet. Smears were made each morning, and the first appearance of cornification was taken as the end-point.

In the first series of observations, 17 sexually mature rats ranging in age from 40 to 60 days at the inception of the experiment were selected from each strain and smeared daily for at least 3 cycles. The average cycle in days for the Yale strain was 5.8 P.E. $\pm$ 0.36 and for the Wistar strain 4.7 P.E. $\pm$ 0.36. There are 8 chances per 100 that the difference is not significant. Sixty-five per cent. of the Yales and 35 per cent. of the Wistars had average cycles of 5 days or more, and 35 per cent. of the Yales and 6 per cent. of the Wistars had average cycles of 6 days or more. The chances that these differences are not significant are 4 and 3 in 100, respectively.

The second series totaled 44 Wistars and 45 Yales ranging in age from 80 to 295 days. One Yale rat, 97 days of age, showed no cycle although smeared for 16 days. Table 1 shows that the cycles averaged 5.48 days for the Yales and 4.45 for the Wistars. The chance that this difference is not significant is less than 1 in 100. Thirty-four per cent. of the Yales but only 9 per cent. of the Wistars have cycles of 6 days or over. The chance that this difference is not significant is less than 1 in 10,000.

In view of the work of Blunn[5] on the relation of the genetic composition of rats to the time of opening of the vagina, it appears important to record that the Yale, more accurately called the Connecticut Agricul-

[8] A. R. Taylor, D. G. Sharp and J. W. Beard, *Jour. Infect. Dis.* In press.
[9] H. Finkelstein, W. Marx, D. Beard and J. W. Beard, *Jour. Infect. Dis.*, 66: 117, 1940.
[10] D. G. Sharp, *Jour. Bact.*, 37: 447, 1939; 39: 535, 1940.
[1] This investigation was supported by a grant from the Committee on Research in Endocrinology, National Research Council.
[2] V. V. Cole and B. K. Harned, *Endocrinology*, 23: 318, 1938.
[3] B. K. Harned and V. V. Cole, *Endocrinology*, 25: 689, 1939.
[4] H. M. Evans, Harvey Lectures, 19: 212, 1924.
[5] C. T. Blunn, *Anat. Record*, 74: 199, 1939.

TABLE 1

A COMPARISON OF THE LENGTHS OF THE ESTRUS CYCLES OF MATURE RATS IN THE WISTAR AND YALE STRAINS. RATS FROM THE TWO STRAINS WERE PAIRED ACCORDING TO AGE. RANGE 80–295 DAYS

Length of cycle in days	No. of rats showing cycle		P*
	Wistar 44 rats	Yale 44 rats	
3	7	5	
4	23	13	
5	10	11	
6	1	5	
7	2	3	
8	0	2	
9	1	3	
11	0	1	
14	0	1	
Average cycle in days ..	4.45 ± 0.13	5.48 ± 0.23	0.009
Percentage 3–5 days	91	66	0.00005

* Chance that deviation is due to sampling.

tural Experimental Station strain, and the Wistar experimental strain used in these studies are genetically different, as shown by the results of mating a piebald male with two Yale and two Wistar females. The 17 offspring from the Yale crosses were black with white paws and vest, while the 21 offspring from the Wistars were all piebald.

The data on the estrus cycle of the Yale rats have been interpreted as further evidence of a hyperfunction of the anterior pituitary in this strain.

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LIFE HISTORY OF SPIRORCHIS PARVUS (STUNKARD) TREMATODA: SPIRORCHIIDAE

THE life history of *Spirorchis parvus,* a monostomate blood fluke from the arterioles of the muscular gut wall of the turtle *Chrysemys picta,* has been completed experimentally in the laboratory. The large non-operculate eggs contain active miracidia when passed from the host; hatching occurs after four to six days' incubation at room temperature. The miracidium is complicated, having a complex sensory apparatus, eighteen dermal plates arranged in four tiers and two pairs of flame cells. Miracidia penetrate young snails of the species *Helisoma trivolvis* Say and *H. campanulatum* Say and develop into elongated mother sporocysts in the mantle of the hosts. Young daughter sporocysts escape from the mother sporocyst sixteen to eighteen days after penetration of the miracidia and migrate to the liver of the snail by way of lymph channels. The young daughter sporocyst has a subterminal birth pore, a spinose anterior end, and contains several young cercarial embryos. The cercaria is an apharyngeal, distomate cercaria of the furcocercous, brevi-furcate type, having a dorsal body crest and compound pigmented eyespots. Body and tail are spinose. The body is humped above the insertion of the tail, broad posteriorly and narrow anteriorly to the ventral sucker. The mouth is subterminal as in schistosome cercariae; esophagus long, ceca short and inflated. The head organ is larger than the ventral sucker, the former is transformed within the final host into the oral sucker while the ventral sucker disappears. The tail-stem is muscular and more than twice the length of the body. The furcae have fin-folds. Both body crest and fin-folds are organs of flotation.

The crest is formed by an elevation of the cuticle above the dorsal mass, but the two cuticular portions are not in contact, thus forming a cavity between the apex of the crest and the dorsal body wall. The crest may be obliterated by extreme elongation of the body, or it may appear even higher than usual when the body is greatly contracted. It may disappear altogether when specimens are placed in hot fixing solutions, but it is demonstrable in specimens fixed in warm or cold solutions.

There are seven pairs of penetration glands in cercariae dissected from the snail, but only six pairs in naturally emerged cercariae. The seven pairs may be divided into four groups; the first group, found only in cercariae dissected from snails, consists of a single pair of small pyriform, mononucleated gland cells located about halfway between the eyespots and the ventral sucker. They and their ducts are filled with coarse granules. The second group contains two pairs of eosinophilic glands, located just anterior to the ventral sucker. The three pairs of glands in the third group are basophilic in staining reaction and are located dorsal and posterior to the ventral sucker. They are larger, more elongated and have more finely granular contents than the first two groups. The fourth group consists of a single pair of large glands located in the extreme posterior part of the body. In naturally emerged cercariae they appear as a single large granular mass and are so reported in related cercariae. The contents of these glands and their ducts are coarsely granular as in the first pair. During most of the developmental period of the cercarial embryo these glands are clearly separate. They migrate posteriorly from near the head organ, where they were first seen, to the posterior end of the body as the embryo grows into a fully developed cercaria. By this time the glands are so overlapped as to appear as one, but their ducts, which may be observed at any stage of development after their first appearance, indicate the paired condition. The presence of the first group of glands in cercariae dissected from snails and their absence in naturally emerged cercariae sug-

gest that the contents of the first pair of glands are used by the cercaria to make its way through the tissues of its snail host.

The identity of *Cercaria parvus* was proved experimentally by rearing adult worms from cercariae and also by rearing cercariae from eggs produced by these adult worms. A detailed comparison of this species with descriptions of *C. wardi* Miller (1923) shows that they differ only in the presence of a dorsal crest on *C. parvus*. A corresponding structure was not described for *C. wardi*. Despite this apparent difference there is a possibility that they are identical. *C. parvus* in its position when floating or resting on the bottom differs from *C. elephantis*, which it closely resembles in structure.

A more complete description of the stages in the life history of this trematode and the development of its excretory system will be presented elsewhere. These researches were supported by a fellowship of the General Education Board.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN AUTOMATIC ZERO PIPETTE FOR DISPENSING STERILE CULTURE MEDIA[1]

AN apparatus constructed in this laboratory in connection with chemical studies on the nature of disease resistance has proved to be convenient in sterilizing and aseptically dispensing measured amounts of liquid culture media into sterile flasks. It is particularly useful when large numbers of flasks are to be filled, as in testing the inhibitory effects of organic compounds using the alcohol sterilization technic described elsewhere.[2] The details are shown in the figure; the measuring device resembles the automatic zero pipettes commercially available but is especially adapted for aseptic use.

The apparatus was made of Pyrex glass throughout and requires one No. 7/25 Standard Taper joint and one three-way stopcock with 2 mm bore; the other parts are readily constructed by any one with an elementary knowledge of glass blowing.

To prepare the apparatus for autoclaving, an upright Erlenmeyer flask of appropriate size (generally 4 liters) containing the nutrient medium is closed with a two-hole rubber stopper bearing the measuring device and an air vent tube A. The stopcock is turned so that air can escape from the flask through the pipette and the openings are plugged with cotton as indicated. The L-shaped tube B leading to the stopcock is pushed as far as it will go into the rubber stopper so that a minimum of head room in the autoclave is required; the level of the liquid in the flask should be below the end of this tube. The air vent tube, which is made of a 2 mm capillary and extends to the bottom of the flask, is closed with a No. 0 rubber stopper to prevent loss of liquid through the tube; this stopper must be removed as soon as the autoclave is opened to prevent the solution from reaching the cotton plug. After the large stopper is fastened in place with the clamp, the top of the flask and the pipette are covered with a folded sheet of wrapping paper and the apparatus placed in the autoclave.

When the system has cooled and is to be used, the paper hood is removed, the stopcock turned to an off position and the L-shaped tube carefully pulled out of the stopper until the end is practically flush with inner surface of the stopper. The expanded rings C of the tube in the stopper aid in preventing any leakage or tendency of the tube to come out of the stopper

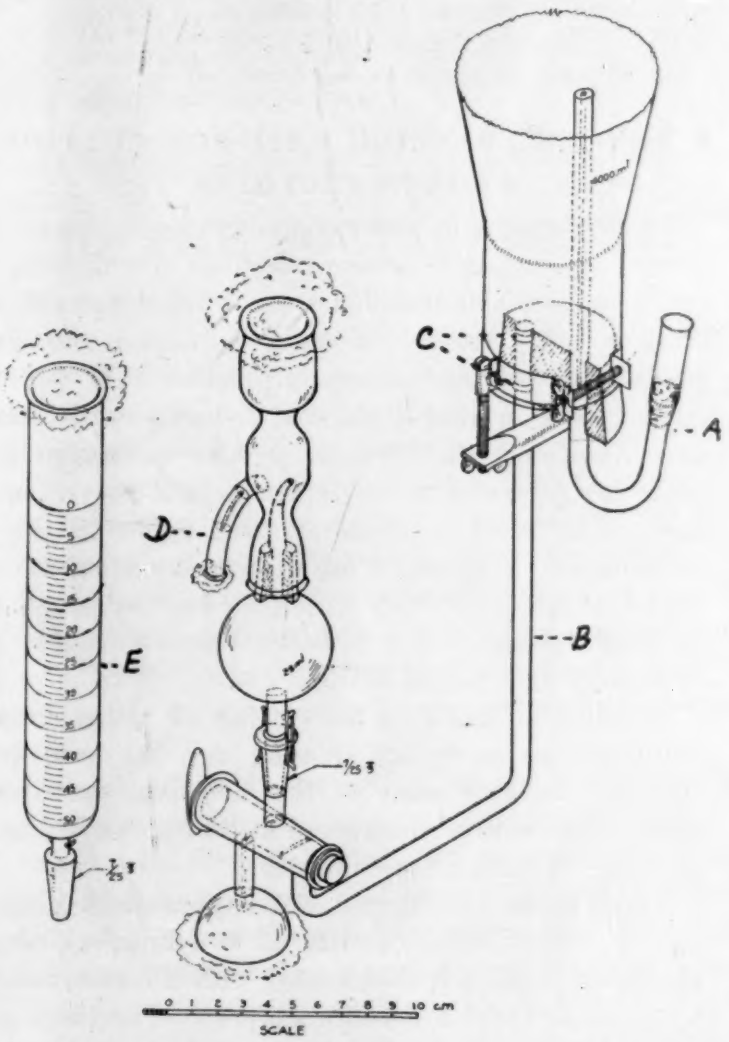

FIG. 1

[1] Approved by the director as contribution No. 598, Technical Series, of the Texas Agricultural Experiment Station.

[2] Glenn A. Greathouse and Neil E. Rigler. Quantitative Comparison of Methods for Sterilizing Solutions of Organic Compounds Used in Culture Media. (In press.)

too readily. The apparatus, after being inverted, is placed in a large split iron ring attached to a ring stand and then has the appearance indicated in the drawing. The cotton in the side arm D of the overflow vessel is removed and a glass tube (not shown) is attached to it by means of a short rubber tube. This glass tube conducts the overflow to a beaker sitting on the table top. The 1 mm constriction in the side arm provides a liquid seal to prevent any chance of contamination through that member. The cotton plug is then removed from the bell-shaped shield and the apparatus is ready for use. The stopcock is turned so that the pipette fills. When a few drops of liquid have run out of the tip at the top, indicating that the pipette is completely filled, the stopcock is turned through 180° and the measured quantity is discharged into a sterile flask which is placed on the table underneath the bell. The interchangeable ground glass joint is provided to facilitate the use of various-sized pipettes from 10 to 100 ml. When different amounts of one solution are to be measured, but with less rapidity and accuracy, a graduated burette E can be inserted, instead of the pipette, by means of the interchangeable joint.

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A DRY-ICE FREEZING UNIT FOR CUTTING FROZEN SECTIONS

THE advantages in time-saving of different freezing methods in cutting microscope sections is well recognized, but available techniques are in many cases difficult or costly to use. Freezing by carbon dioxide gas is both costly and tedious in practice. The use of commercially available dry-ice freezing units has some disadvantages. Ordinarily these units are too small for pieces of tissue larger than 2 square cm, they fail to freeze the tissue uniformly, since the dry-ice container is arranged on an arm extending from the tissue table, and they do not hold enough dry ice to keep the tissue at a uniform temperature for a sufficiently long period of time.

In order to facilitate the cutting of rather large brain sections, a dry-ice freezing unit has been devised to eliminate many of the difficulties described above. The unit is constructed so that it can be used on different kinds of microtomes.

Fig. 1 presents a diagram of the apparatus in cross-section. The device consists of a cylindrical cast-aluminum container, constructed with a center table, to which is fitted a bakelite support. The block of tissue to be sectioned is placed on the center table, which is grooved in concentric circles, and powdered dry ice is packed around it within the container. The bakelite support is clamped to the block-holder of the microtome.

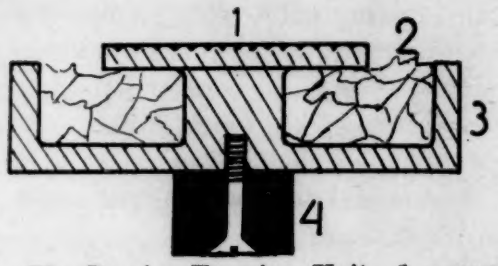

FIG. 1. The Dry-ice Freezing Unit: 1 represents the circular table of the freezing unit, 2, the circular container into which the dry ice is packed, 3, the side wall, and 4, the bakelite support, which is clamped into the block-holder of the microtome.

The dry-ice container measures 8.4 cm in diameter, 2 cm in height, and has a wall and base 0.4 cm thick. The tissue table is supported at the center of the container on a base 1.5 cm in diameter. The table itself is 5 cm in diameter and 0.5 cm thick, and is raised 0.2 cm above the wall of the container in order to avoid the possibility of fouling the knife. The hexagonal bakelite support is 1.5 cm high and 2.5 cm in width. Additional economy of space may be secured by constructing the apparatus so that the base support may be clamped directly in the microtome, thus eliminating the block-holder.

Using this device, complete frontal sections of the brains of large dogs, 30, 40 and 50 microns in thickness, have been cut very satisfactorily. The tissue is frozen uniformly since the tissue table is completely surrounded by dry ice. The dry ice keeps well, for it is partly enclosed within the container. Furthermore, the container is insulated from the metal of the microtome by the bakelite support. In these respects the freezing unit described has been found superior to other devices of this sort, both those which utilize dry ice or carbon dioxide gas in order to freeze the tissue.[1]

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[1] The freezing unit described may be obtained from Merle Hanford, Physics Department, University of Rochester, Rochester, N. Y.

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